

# **An Update on the Lamar, Colorado On-Farm Digester**



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Energy Conference**

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# Office of Energy Management and Conservation Overview

- **Serves Colorado people and businesses through the demonstration and education of viable, real-world energy solutions and through application of weatherization programs**
- **Federally funded; No Colorado tax dollars**
- **Founded in 1977**

# Colorado Pork, LLC. Lamar, CO

- **Became Operational in 1999**
- **A typical breed-to-wean Confined Animal Feed Operation (CAFO) with approximately 5,500 sows & 1,200 gilts**
- **Built to be both an energy and water-efficient CAFO**
- **Immediately impacted by odor regulations mandated by Colorado Constitutional Amendment #14**
- **Uses an anaerobic digester for wastewater treatment and energy production**

# Anaerobic Digester



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# Evaporative Lagoon





- **Biogas produced is burned in a 75 kW modified natural gas reciprocating engine with a generator set and/or a 30 kW Capstone micro turbine**
- **Gas not utilized is flared**

# Reciprocating Engine and Generator Set



- Parallel-tied to the grid
- Able to run while farm receives grid-produced electricity to meet needs above on-site production

# Capstone Micro Turbine (MT)

- **MT and associated equipment installed in October 2001**
- **Runs alone or concurrently with reciprocating engine**
- **Parallel-tied to grid**





# Electrical Interconnection

- **Interconnection was done in partnership with Southeast Colorado Power and Tri State G&T to test two-way transmission between farm and utility**



# Electrical Generation

- **Generator produces approx 35% of farm's kWh and 50% of its peak power ( $\approx 65$  kW)**
- **Colorado Pork pays approx \$3,500 for electricity/month**
- **Other local hog CAFOs of equivalent operational size pay between \$10,000 - \$11,000 per month**



# Comparison Study: MT vs. Reciprocating Engine

- **Comparison tests use the same gas stream in real time**
- **An EPA Greenhouse Gas Verification test was recently concluded - awaiting results (Initial findings suggest the MT's emissions are significantly better than those for the reciprocating engine but that the MT's installation costs cannot justify a single MT configuration – multiple unit configurations can capture significant savings by sharing use of adjunct equipment needed for the single unit and bring the overall cost per kW more in line with the reciprocating engine)**
- **A longer, one-year direct comparison between the MT and reciprocating engine will be done**

# Other Completed and Planned Tests

- Completed year-long evaluation of digester inputs and outputs
- Planned testing of “microbial accelerant” to assess potential gas increase from digestion by “super” bugs
- Planned comparison testing between reciprocating engine, MT and 55 kW Stirling engine scheduled to begin this Fall (Partnership includes OEMC, EPRI, Tri State G & T and SECP)

# STM Power Stirling Engine



COMPARATIVE COST ANALYSIS TO MEET COLORADO'S AMENDMENT 14 FOR A 5000 SOW FARM

SYSTEM TYPE	ACTUAL CONSTRUCTION COSTS TO NEAREST \$500	NET ELECTRICITY COSTS SAVED PER YEAR
Single Cell Lagoon	\$301,500	Zero
Two Cell Lagoon	\$357,500	Zero
Covered Single Cell Lagoon	\$476,500	Zero
Covered Two Cell Lagoon	\$473,500	Zero
Anaerobic Digester (w/ small scale single cell lagoon and 75kW genset)	\$375,000	\$40,000 (if \$.0675/kWh)
Retrofit To Add AD and Genset For Any Of First Four Above	Additional \$250,000, approximately	\$40,000 (if \$.0675/kWh)

# Approximate Amount of Bio-Power and Bio-Waste Produced per Each:

- **Dairy cow – 150W (Ea. cow yields 15 tons/yr)**
- **Feedlot cow – 100W (Ea. cow yields 10 tons/yr)**
- **Hog – 11W (Ea. hog yields 1.1 tons/yr)**
- **Human – 2.5W (Ea. human yields 500lbs/yr)**
- **Chicken – 1.2W (Ea. Chicken yields 240 lbs/yr)**

## **Examples of power production:**

**-A 500,000 head feedlot could generate 50MW to power up to 50,000 average-sized homes; based on an average monthly consumption basis of 720 kWh/month**

**-The US human population could theoretically provide approx. 700MW, enough to power 700,000 US homes.**

# Facts About ADs

- Cost to install an AD, from scratch, is approximately \$60 to \$100 per hog, and \$300 to \$600 per dairy cow, depending on type of AD and level of system complexity
- Most existing farm ADs are built for hogs and dairy cows but they also are used for fowl and feedlot cattle
- Gas streams from ADs have 5K to 6K ppm of H<sub>2</sub>S for hogs and 300 to 400 for cows and humans. H<sub>2</sub>S causes considerable problems and is most of odor problem. Much of H<sub>2</sub>S comes from water supplied to facility
- An AD, generally speaking, is simple to run – taking, on average, about one hour per day for a Lamar-like facility and most, when built and maintained properly, operate at over 90% up time (one system has been operating for over 25 years and its longest down time has been less than 15 minutes)

# However:

CAFOs with ADs, like most animal farms, operate on very small profit margins and, therefore, their

- first concern is product output and problems with output take precedence over AD problems

- turnover of employees assigned to operate AD can be high

- full understanding of AD system can be difficult

- facility remoteness can mean slow, or almost-no, response by electricians, engine technicians, plumbers, AD experts, etc.

- reciprocating engines modified to burn dirty, low BTU gas can be difficult for local technicians unfamiliar with engine changes to understand

# On The Other Hand:

ADs can

- utilize the “free” methane to make electricity, and provide from one-third to over 100 percent of the CAFOs’ needs
- lower or eliminate peak demand charges; further reducing electricity costs
- reduce the effects of potential air and water pollution and help control the release of methane to the atmosphere (methane is 21 times more potent than CO<sub>2</sub> as an atmosphere-altering gas)
- provide essentially complete destruction of H<sub>2</sub>S
- greatly decrease outputs of volatile acids and solids
- reduce the size of the farm’s waste lagoon; by as much as two-thirds, thereby considerably offsetting cost of AD
- offer an excellent way to meet or lessen impact of existing or future health regulations governing air and water emissions

# Some General Recommendations for ADs

- Encourage their adoption by many animal farms and other animal containment operations (e.g., zoos)
- Encourage, where feasible, construction of centralized ADs; i.e., those that can serve several CAFO facilities or several facilities with different waste streams (e.g., CAFOs, slaughter houses, cheese factories, food wastes, distillery waste, etc.)
- Work with Energy Service Companies (ESCOs) and energy providers to build ADs with outside capital and/or on-site operation
- Encourage Combined Heat and Power (CHP) through best-fit uses of heat generated during electrical production
- Work with researchers developing new anaerobic microbes capable of accelerating the digestion process of single or multiple product bio-waste streams
- Conduct workshops to acquaint prospective users of ADs' benefits and discuss case studies and ongoing funding opportunities

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